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THE BATS OF FLORES, INDONESIA, WITH REMARKS ON ASIAN *TADARIDA*

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ABSTRACT. The Museum of Comparative Zoology at Harvard University holds an unreported collection of bats from Flores in the Lesser Sundas. These specimens, including a remarkable record of the Palearctic molossid *Tadarida teniotis* from the island, are reported here. The Flores specimen of *T. teniotis* is compared with other *Tadarida* from the region, including three specimens of *T. latouchei* from Laos, reported here for the first time. A list of bats recorded to date from Flores is presented. Additional field collecting must ensue before a coherent understanding of mammalian patterns of zoogeography and species richness in the Lesser Sundas, and especially Flores, will emerge.

INTRODUCTION

Flores is the third largest of the Lesser Sundas (Nusa Tenggara), the archipelago of Indonesian islands extending east from Java (Fig. 1), comprising many medium-sized islands, including Bali, Lombok, Sumba, Sumbawa, Komodo, and Timor. The Lesser Sundas are especially interesting to biogeographers; bounded to the west by Java, to the south by Australia, and to the north and east by the Moluccas and New Guinea, these islands form

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Figure 1. Map of the Malay Archipelago spanning the distance between Southeast Asia and Australia, showing the central position of Flores in the Lesser Sundas.

the southern and eastern limit in the region for insular faunas that are characteristically Asian, rather than Australian, in origin.

The Museum of Comparative Zoology (MCZ) holds zoological collections made by the Reverend J. A. J. Verheijen on Flores in the late 1950s and early 1960s. The birds and native murids that Verheijen collected have been discussed (Musser, 1981; Paynter, 1963); however, a small collection of bats that he assembled remains unreported.

The past decade has seen numerous systematic revisions of the bats of the Lesser Sundas, which we draw from in identifying bats in Verheijen's collection (see species accounts below). Despite the increased attention paid in recent years to mammal faunas in the Lesser Sundas, many of these islands have not been surveyed adequately. The Lesser Sundas have revealed a much larger degree of mammalian endemism than was previously suspected (Kitchener and Suyanto, 1996:10), and this rate of alpha-level systematic discovery is unlikely to subside any time soon if survey work is continued. Despite its relatively large size, knowledge of the mammalian fauna of Flores remains obscure, and new discoveries likely await future expeditions and continued

investigation of museum specimens from the island. Thus, although a coherent understanding of Lesser Sundaic mammalian biogeography is emerging, many questions regarding distribution and species richness among the islands in this region remain to be answered.

Verheijen's collection of bats from Flores comprises nine species, described below. Common names follow Wilson and Cole (2000).

SPECIES ACCOUNTS

Pteropus lombocensis heudei Matschie, 1899
Lombok Flying Fox

Specimen. MCZ 56952, male, skin only, collected at Endeh on the southern coast of Flores, East Nusa Tenggara, Indonesia, on 30 November 1959.

The taxonomy and zoogeography of *P. lombocensis* were reviewed by Kitchener and Maryanto (1995) and Kitchener *et al.* (1995b).

Measurements. Length of forearm, 106.7 mm.

Acerodon mackloti floresii (Gray, 1871)
Sunda Fruit Bat

Specimen. MCZ 56960, unsexed, immature, skull, collected on Flores (locality unspecified), East Nusa Tenggara, Indonesia, in "early 1960s."

Flores is the type locality of this bat, as suggested by its trinomial epithet. Koopman (1994:27) retained this form as a valid subspecies restricted to Sumbawa and Flores, but a thorough examination of specimens from throughout the Lesser Sundas will probably bring marked changes to the classification of *A. mackloti* at the subspecific level. Specimen MCZ 56960 is an immature animal, with its dentition not fully erupted and its braincase and nasal sutures poorly ossified.

Measurements. Greatest length of skull, 51.6 mm; condylobasal length, 48.8 mm; interorbital breadth, 7.0 mm; maxillary tooth row, broken, unavailable.

Dobsonia peronii peronii (E. Geoffroy, 1810)

Western Naked-backed Fruit Bat

Specimen. MCZ 51111, female, skin only, collected at Mano (10 km east of Ruteng), western Flores, East Nusa Tenggara, Indonesia, in December 1958.

Geographic variation in this Lesser Sundaic endemic was conclusively discussed by Kitchener *et al.* (1997a) and Bergmans (1978). This specimen is a skin in good condition, unlike many of Verheijen's study skins, which were damp and putrid when his shipment of mammals was received by the MCZ.

Measurements. Length of forearm, 119.3 mm.

Cynopterus nusatenggara nusatenggara Kitchener and

Maharadatunkamsi, 1991

Nusa Tenggara Short-nosed Fruit Bat

Specimen. MCZ 56953, unsexed, immature, skin and skull, collected at Potjong, Lamba Leda, Flores, East Nusa Tenggara, Indonesia, on 5 January 1960.

This recently-described bat has been variably assigned to the synonymy of *Cynopterus brachyotis* (Hill, 1992:70) or treated as a valid species (Koopman, 1993:139). This specimen is a juvenile individual, represented by a skull and a skin in poor condition. *Cynopterus nusatenggara* is the only *Cynopterus* species known from Flores, to which this specimen is tentatively attributed.

Measurements. Length of forearm, 52.1 mm; greatest length of skull, 26.9 mm; condylobasal length, 25.1 mm; interorbital breadth, 5.3 mm; maxillary tooth row, 8.7 mm.

Rhinolophus affinis princeps Andersen, 1905

Intermediate Horseshoe Bat

Specimens. MCZ 51118, male, skin, collected at Ruteng, western Flores, East Nusa Tenggara, Indonesia, on 16 June 1959; MCZ 56962, unsexed, skull, collected on Flores (locality unspecified), East Nusa Tenggara, Indonesia, received by MCZ in "early 1960s."

This subspecies has been recorded previously from Flores by Bergmans and van Bree (1986:335), Hill and Rozendaal (1989:100), and Purnomo and Bangs (1995:32). It is also found on

Lombok, Sumbawa, and Sumba (Koopman, 1994:54). The MCZ holds two additional female specimens of this subspecies collected in 1927 at Wawo on Sumbawa.

Measurements. MCZ 51118: Length of forearm, 53.2 mm. MCZ 56962: Greatest length of skull, 23.1 mm; condylobasal length, 20.6 mm; interorbital breadth, 2.2 mm; maxillary tooth row, 9.3 mm.

Hipposideros diadema diadema (E. Geoffroy, 1813)
Diadem Roundleaf Bat

Specimens. MCZ 51109, female, skin, collected 2 May 1959, and MCZ 51110, male, skin and skull, collected 25 June 1958, both taken at Mano (10 km east of Ruteng); MCZ 56961, unsexed, skull, collected on Flores (locality unspecified), East Nusa Tenggara, Indonesia, received by MCZ in "early 1960s."

Kitchener *et al.* (1992) reviewed geographic variation in *H. diadema* from the Lesser Sundas. Verheijen's notes state that MCZ 51109 was collected at an altitude of 900 m.

Measurements. MCZ 51109: Length of forearm, 85.9 mm. MCZ 51110: Length of forearm, 83.4 mm; greatest length of skull, broken, unavailable; condylobasal length, broken, unavailable; interorbital breadth, 3.4 mm; maxillary tooth row, 12.8 mm. MCZ 56961: Greatest length of skull, 30.7 mm; condylobasal length, 28.4 mm; interorbital breadth, 3.5 mm; maxillary tooth row, 12.6 mm.

Myotis muricola muricola (Gray, 1846)
Whiskered Myotis

Specimen. MCZ 51114, unsexed, skull, collected on Flores (locality unspecified), East Nusa Tenggara, Indonesia, received by MCZ in October 1961.

Myotis muricola is a wide-ranging bat of southern and south-east Asia. Hill (1983) discussed the taxonomy of this species, and considered representatives of *M. muricola* from the Lesser Sundas to represent the nominate subspecies. Interestingly, no names in the synonymy of *M. muricola* originate from either the Greater or Lesser Sundas, with the exception of the distinctive *M. m. niasensis* of Pulau Nias off western Sumatra (Hill, 1983; Lyon,

1916). A careful review of geographic variation in this species across its wide distribution is needed.

Measurements. Greatest length of skull, 13.2 mm; condylobasal length, 12.5 mm; interorbital breadth, 2.9 mm; maxillary tooth row, 5.1 mm.

Scotophilus collinus Sody, 1936

Sody's Yellow Bat

Specimen. MCZ 51115, unsexed, skull and postcranial skeleton, collected at Ruteng, western Flores, East Nusa Tenggara, Indonesia, on 15 June 1959.

Kitchener *et al.* (1997b) reviewed the taxonomy of *Scotophilus* in the Lesser Sundas; previously, *Scotophilus* specimens from Flores were considered to represent *S. kuhlii temmincki* (see Koopman, 1994:128).

Measurements. Greatest length of skull, 19.9 mm; condylobasal length, 18.6 mm; interorbital breadth, 4.8 mm; maxillary tooth row, 6.6 mm.

Tadarida teniotis (Rafinesque, 1814)

European Free-tailed Bat

Specimen. MCZ 56950, unsexed, skin and skull, collected at Endeh on the southern coast of Flores, East Nusa Tenggara, Indonesia in July 1960.

Specimen MCZ 56950 is the most interesting bat collected on Flores by Verheijen. It represents a remarkable range extension for *T. teniotis*, a bat widely distributed throughout Europe, North Africa, and Asia. Previously, southern China was the most southeastern geographic record for *T. teniotis*; this Flores specimen extends the range of this bat almost 2,500 miles (= 4,000 km).

We have compared MCZ 56950 with *Tadarida* from other Asian localities (Table 1). Three specimens from Laos, examined in the Natural History Museum, London, are considerably smaller than other Asian, even south Chinese, *T. teniotis*. These specimens provide further support for Kock's (1999) recognition of *Tadarida latouchei* as a southeast Asian species distinct from *T. teniotis*, and firmly establish the previously disputed claim that this bat is present in Laos (Salter, 1993; see Kock, 1999:239).

TABLE 1. MEASUREMENTS OF ASIAN *TADARIDA TENIOTIS* AND *T. LATOUCHEI*.¹ All measurements are given in millimeters.

	Israel ²	Tajikistan ³	Kyrgyzstan ⁴	China ⁵	China ⁶	Flores ⁷	Laos ⁸	Laos ⁹	Laos ¹⁰	Thailand ¹¹
CB	ND	23.5	23.7	24.7	24.8	23.4	21.0	20.3	20.7	21.4
GLS	25.1	24.1	24.4	25.3	25.2	24.1	22.3	21.3	21.7	22.3
BB	11.8	11.4	11.6	11.7	11.8	11.8	10.5	10.4	10.6	11.0
IOB	4.9	4.8	4.9	5.1	4.7	4.7	4.8	4.6	4.9	4.7
ZB	14.5	14.1	14.3	ND	14.7	14.5	12.7	12.8	13.0	12.5
MTR	9.0	8.9	9.2	9.6	9.5	8.9	8.1	7.7	8.0	8.3
PL	10.8	10.5	ND	10.6	ND	10.5	9.5	8.5	8.9	ND
ML	17.8	ND	ND	18.3	18.1	17.2	15.5	14.8	15.1	15.4
FA	61.5	59.6	61.5	ND	62.8	63.6	ND	ND	ND	55.7

¹ Abbreviations: CB, condylobasal length; GLS, greatest length of skull; BB, breadth of braincase; IOB, interorbital breadth; ZB, zygomatic breadth; MTR, length of maxillary toothrow (C-M3); PL, palatal length; ML, mandible length; FA, length of forearm; ND, no data available; MCZ, Museum of Comparative Zoology, Harvard University; AMNH, American Museum of Natural History, New York; SMF, Senckenberg-Museum, Frankfurt, Germany; BMNH, Natural History Museum, London, United Kingdom; ZFMK, Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn, Germany.

² *T. teniotis*, MCZ 8680, male adult, Israel. Measured by authors.

³ *T. teniotis*, AMNH 245384, female adult, Babatog Mts., Tajikistan. Measured by authors.

⁴ *T. teniotis*, SMF 77805, female adult, Sasik Ungur, Kyrgyzstan. Reported by Kock (1999:238).

⁵ *T. teniotis*, BMNH 26.11.15.54, male adult, China. Measured by authors.

⁶ *T. teniotis*, ZFMK 50.239, female adult, Woping, 40km S of Shao-wu, NW Fujian, China. Reported by Kock (1999:238).

⁷ *T. teniotis*, MCZ 56950, unsexed adult, Ende, Flores. Measured by authors.

⁸ *T. latouchiei*, BMNH 94-205, unsexed adult, Laos. Measured by authors.

⁹ *T. latouchiei*, BMNH 94-206, unsexed adult, Laos. Measured by authors.

¹⁰ *T. latouchiei*, BMNH 94-207, unsexed adult, Laos. Measured by authors.

¹¹ *T. latouchiei*, SMF 86457, male subadult, Khok Nok Kaba, NE Thailand. Reported by Kock (1999:238).

Verheijen's specimen of *Tadarida* from Flores is larger than the southeast Asian *T. latouchei*, and agrees closely in cranial and dental measurements with specimens of *T. teniotis* from China and Central Asia (Table 1), and with measurements for European *T. teniotis* reported in the literature (Kock and Nader, 1984). The presence of outer lower incisors and an unreduced anterior upper premolar are dental traits that demonstrate that MCZ 56950 is allied with *T. teniotis* and *T. latouchei* of Asia, and not with Australasian (New Guinean *T. kuboriensis* or Australian *T. australis*) or Indian (*T. aegyptiaca* of the Indian subcontinent) bats of the genus *Tadarida* (*sensu* Koopman, 1993). The other bats of the island also bear close affinity to Asian rather than Australian bats, despite the proximity of Flores to Australia and the Moluccas. (The zoogeographic relationships of the murid rodents from Flores are presently less clear; see Musser, 1981:163.)

Remarkable range extensions of bats reported in the literature can often be the result of mistaken locality information, or of rare vagrants. The first seems to be unlikely in this case, because Verheijen sent one specimen of *T. teniotis* in the midst of a shipment of other mammals assuredly from Flores, and it is accompanied by good original tags and unambiguous locality information. We believe this specimen does not represent an unusual vagrant, for several reasons. First, its collection locality, on the southeastern coast of Flores, is about the most distant site on the island for an individual traveling from mainland Asia. However, because long-distance seasonal migrations have been reported in North American *Tadarida brasiliensis* (Glass, 1982; McCracken *et al.*, 1994), the possibility that this was an individual on a currently undocumented migration route should not be disregarded. In addition, it should be noted that *T. teniotis* is rarely collected even over wide areas within its known range (see Kock, 1992; St. Pandurska, 1992), and that the microchiropteran fauna of the Lesser Sundas is assuredly far from being fully characterized. *Tadarida teniotis* is the first molossid species reported for Flores; further mammal collecting on Flores and possibly other Sundaic islands may reveal additional individuals or populations of *T. teniotis* in the region. If this is the case, representatives of this species from the Lesser Sundas may prove upon exami-

TABLE 2. THE BAT FAUNA OF FLORES; COMPILED FROM LAURIE AND HILL (1954), HILL AND ROZENDAAL (1989), KITCHENER AND MAHARADATUNKAMSI (1991), KITCHENER ET AL. (1992), KITCHENER AND MARYANTO (1993), KITCHENER ET. AL (1995A), KITCHENER ET. AL. (1995C), MAHARADATUNKAMSI AND KITCHENER (1997), KITCHENER ET AL. (1997B), AND THIS PAPER.

Pteropodidae

- Pteropus lombocensis heudei* Matschie, 1899
Acerodon mackloti floresii (Gray, 1871)
Rousettus amplexicaudatus infumatus (Gray, 1871)
Dobsonia peroni peroni (E. Geoffroy, 1810)
Cynopterus nusatangara nusatangara Kitchener and Maharadatunkamsi, 1991
Eonycteris spelaea glandifera Lawrence, 1939

Emballonuridae

- Taphozous longimanus leucopleurus* Dobson, 1875

Rhinolophidae

- Rhinolophus affinis princeps* Andersen, 1905
Rhinolophus simplex simplex Andersen, 1905
Hipposideros bicolor bicolor (Temminck, 1834)
Hipposideros diadema diadema (E. Geoffroy, 1813)
Hipposideros sumbae sumbawae Kitchener and Maryanto, 1993

Vespertilionidae

- Myotis muricola muricola* (Gray, 1846)
Myotis adversus adversus (Horsfield, 1824)
Scotophilus collinus Sody, 1936
Pipistrellus javanicus (Gray, 1838)
Murina florium florium Thomas, 1908
Kerivoula flora Thomas, 1914

Molossidae

- Tadarida teniotis* (Rafinesque, 1814)
-

nation of additional specimens to be subspecifically distinct from the Asian *T. t. insignis*.

The presence of *T. teniotis* on Flores brings the recorded bat fauna of the island to 19 species (Table 2), encompassing 15 genera and five families. This number will no doubt increase with future fieldwork, and we predict that the Lesser Sundas will continue to yield both new records and new species of mammals, providing over time a more complete understanding of patterns of zoogeography and species richness in the region.

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NOTE ADDED IN PROOF:

In their catalogue of the Heude Collection of mammals at the Institute of Zoology, Chinese Academy of Sciences, Beijing, Braun et al. (2001) listed a bat collected on Flores in 1895, attributable to the megachiropteran genus *Nyctimene* (a juvenile female, skin and skull). We know of only one other *Nyctimene* specimen collected in the Lesser Sundas, an adult male (skin and skull) from Timor (BMNH 9.1.4.8; see Andersen 1912). The Flores specimen should provisionally be referred to *Nyctimene cephalotes* (otherwise known from Sulawesi and the Central Moluccas), as has been done in the past for the Timor specimen (Andersen, 1912; Goodwin, 1979; Kitchener *et al.*, 1995).

This additional record brings the total number of bats recorded from Flores to 20 species and 16 genera.

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